Comparison of Relative Economic Impacts in Utah of Coal-, Natural Gas-, and Wind-Generated Electricity

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8 January 2007

This work was funded by United States Department of Energy Technical Assistance Program (TAP) Grant # 115

Background

At the request of the Utah State Energy Program (SEP), this author conducted an analysis of the relative economic impacts to Utah of using coal versus natural gas versus wind energy for electricity generation. The analysis was supported by a U.S. Department of Energy Technical Assistance Program (TAP) grant.

Methodology/Assumptions

The analysis was performed using the Jobs and Economic Development Impact (JEDI) model developed by Marshall Goldberg on behalf of the U.S. Department of Energy's Wind Powering America (WPA) program. JEDI consists of three separate modules used to analyze the economic impacts of electricity generated from coal, natural gas, and wind. The wind module has been in use for approximately three years. The coal and natural gas modules have only recently been developed.

At the time of this writing, only the wind module is available for download (http://www.eere.energy.gov/windandhydro/windpoweringamerica/filter_detail.asp?itemid=707). The other modules will be posted soon on the WPA Web site (www.windpoweringamerica.gov).

The JEDI modules are spreadsheet-based analysis tools utilizing industry multipliers derived from the IMPLAN economic impact analysis software. JEDI can be used to model the economic impact (jobs, earnings, and economic activity) of a project on an area as small as a county or as large as a nation as a whole. For this analysis, the area of interest is the state of Utah. While JEDI is designed to be used by individuals who may not be familiar with economic impact modeling, users still must take care to incorporate appropriate values for the local spending that occurs and multipliers for the region (i.e., state or county) in which the project is located.

Multipliers show the effect of spending within the area being analyzed, in this case the state of Utah. Essentially a dollar spent on "x" will ripple through the economy, causing changes in spending for "y" and "z." How much rippling occurs for a given amount of spending depends on what "x" is. The economic impacts of spending on concrete are different than the impacts of spending on banking services. JEDI modules include multipliers for every U.S. state.

The other important class of inputs to the model is the "local share." This is the fraction of spending on a given component or service that actually goes to a provider within the area being analyzed (in this case Utah) rather than imported from outside the area. Only the in-state spending portion ripples though the Utah economy. Dollars spent out-of-state, often referred to as leakages, immediately leave the local economy and do not benefit the local area. For each type of power plant, the respective JEDI module provides default values for local shares. After review by staff within the Utah State Energy Program, these values were determined to be appropriate for the analysis.

The JEDI modules break down the analysis into the construction period and the operations and maintenance (O&M) period. The construction period typically involves a large amount of activity for a relatively short period of time while the facility is constructed. After construction, the O&M period, the time during which the facility operates, commences. Compared to the construction period, this period typically sees a smaller economic impact on an annual basis. However, in the case of power plants, this period is often 20 to 30 years, much longer than the construction period. The difference between the construction and O&M periods is important because it shows how the economic impact is felt over time. Construction period effects occur before the plant begins operating and for a relatively short time frame (1 to 4 years), while the O&M period effects are felt over the long term.

This analysis only examines economic impacts resulting from the construction and operation of the power plants and their associated materials and fuel supply chains. The analysis implicitly assumes that each technology produces electricity at the same cost and that the new electricity generated is provided to consumers at the same costs as existing generation. Differences in economic impact due to differences in rate impacts between the technologies are not considered in the analysis. With current and projected natural gas prices, new natural-gas-fired power plants produce electricity at a higher cost than either new coal-fired power plants or new wind farms, which have a similar cost of energy. However, the fuel costs of coal and natural gas are variable, and both have trended upward in recent years. Power purchase agreements for wind typically involve stable price structures. The JEDI model does not factor changing fuel or power price into its calculations.

Figure 1: Key Analysis Assumptions

Key Assumptions	
System Descriptive Data - Wind	
Project Size - Nameplate Capacity (MW)	2,500
Capacity Factor (Percentage)	36%
Construction Cost ($/kW)	$1,600
Annual Direct Operations and Maintenance Cost ($/kW)	$25
System Descriptive Data - Coal	
Project Size - Nameplate Capacity (MW)	1,000
Capacity Factor (Percentage)	90%
Heat Rate (Btu per kWh)	9,550
Construction Period (Months)	48
Plant Construction Cost ($/kW)	$1,540
Cost of Fuel ($/mmbtu)	$1.30
Fraction of Coal Produced Locally (Percent)	100%
Fixed Operations and Maintenance Cost ($/kW)	$40
Variable Operations and Maintenance Cost ($/MWh)	$1.75
System Descriptive Data - Natural Gas	
Project Size - Nameplate Capacity (MW)	1,500
Capacity Factor (Percentage)	60%
Heat Rate (Btu per kWh)	7,000
Construction Period (Months)	24
Plant Construction Cost ($/kW)	$667
Cost of Fuel ($/mmbtu)	$5.20
Fraction of Natural Gas Produced Locally (Percent)	25%
Fixed Operations and Maintenance Cost ($/kW)	$10
Variable Operations and Maintenance Cost ($/MWh)	$2.30

The JEDI model also does not factor the statewide costs of potential fuel price increases to utility ratepayers. It only calculates benefits attributable to the construction and operation of power plants and (in the case of a fuel producer such as Utah) to the production of gas or coal to fuel such plants.

Key assumptions are listed in Figure 1. More detailed assumptions are contained in Appendix A. Utah State Energy Program staff reviewed all values for local shares, construction costs, and O&M costs.

To provide a consistent comparison basis, the power plants for each technology were sized to produce equal amounts of electricity. The baseline is a 1000-MW coal plant operating at a 90% capacity factor (CF). Natural gas plants typically have lower capacity factors because they are used more as intermediate plants rather than base load power. This analysis assumes a 1500-MW natural-gas-fired plant operating at a 60% CF. In reality this would most likely be three or four separate smaller plants. For the purposes of this analysis, the economic impacts would be similar. Due to the variable nature of the wind resource, wind farms in the U.S. typically operate at a 30% to 40% CF. This analysis assumes 2500 MW of wind farms operating at a 36% CF. This does not mean that the wind farm operates only 36% of the time. Wind turbines typically produce energy 70% to 90% of the time, but the power output is often less than the rated capacity due to variable wind speeds.

The analysis assumes the power generating and plant equipment for all the technologies come from out-of-state suppliers. For natural gas and coal, this represents about 50% of the total cost of the facility. For a wind farm, these components comprise 85% of the cost of the facility. Thus the economic impact of building these facilities comes mostly from the installation and construction activities and local materials used in civil works.

Another key assumption is that the power plants are owned by out-of- state entities.

A key input for fossil fuel plants is the fraction of the fuel that is produced in-state. For coal, the base case assumption is that 100% of the fuel comes from within Utah. For natural gas, the situation is more complicated. Utah is a net natural gas exporter. However, a great deal of natural gas, equivalent to two to three times Utah's annual production, is transshipped through Utah. Thus 75% of the natural gas flowing in the pipelines within Utah comes from out of state. No information is available on the fraction of in-state natural gas used in Utah natural-gas-fired power plants. This analysis assumes a value of 25% in-state natural gas for the base case. A sensitivity analysis (assuming 0% and 100% in-state fuel for both coal and natural gas, and 25% in-state fuel for natural gas) was performed to determine the individual impacts of the power plant and fuel supply chain. The SEP staff also provided fuel cost data. Sensitivity analysis over varying fuel costs was also performed.

Property tax rates were researched by SEP staff. JEDI has no mechanism to reduce the annual taxes as facilities depreciate. To account for this, a value of 75%, rather than 100%, was used for the taxable value to better estimate the average annual property tax payments over 20 years. This author does not know how property taxes for the coal and natural gas power plants compare to other states. For wind plants, the estimated annual property tax is $15,600/year per megawatt. This is more than two times the national average for wind farms. Figure 2 shows that on a per-kWh basis, Utah wind farms will pay four times more in property taxes than natural gas plants and almost three times more in property taxes than coal plants.

Results - Background

Figure 2 provides detailed results for selected cases. The selected cases compare the different technologies and the effect of procuring fuel in-state versus out-of-state. Figure 2 will be explained in some detail for the benefit of readers who are not economic impact analysis specialists. After this the actual results will be discussed.

As stated earlier, the economic impacts are given for both the construction period and the O&M period. The former provides a large but short-term boost to the economy; the latter provides a smaller but continuing boost. This analysis assumes a 20-year O&M period. These impacts are described in three ways: number of jobs, earnings, and output. Jobs generated during the construction phase are reported in job-years. This refers to one full-time job for 1 year. For example, if plant construction results in a total of 100 local jobs (job years) and the construction period is 4 years, we can assume there is an average of 25 jobs for each of the years (100 / 4), not 100 jobs each year during the 4-year period. This average number of jobs may be somewhat misleading since the actual number of jobs may vary during the time period. During the O&M period, the estimated number of jobs is actual jobs supported each year. Earnings are defined as wages and salaries. Output is the measure of total economic activity related to a project. In addition to earnings, output includes sales of materials, equipment, and services.

The overall economic impact for both the construction period and the operations period is further broken down into the direct, indirect, and induced impacts. Direct impacts are those impacts that flow directly from project expenditures. An example is buying and installing concrete for foundations. Indirect impacts flow indirectly from the project. These can be considered the first ripples. An example is the concrete plant buying cement from its suppliers. Induced impacts arise from the extra cash in the pockets of those directly and indirectly employed by the project. An example is increased sales at local stores, car dealers, or at the local sandwich shop that sells sandwiches to the foundation crews, workers at the concrete plant, and the workers at the business that supplies cement to the concrete plant.

When examining JEDI results, it is more realistic to look at the magnitude of the values as opposed to the exact value of the results. For example, a value of 800 jobs, given for some impact, could well be 600 jobs or 1000 jobs.

Results – Overview

Detailed results for the base cases are given in Figure 2. Figure 3 and Figure 4 show the relative contributions of the construction period and operations period to output and earnings. Figure 5 shows the jobs created during the construction and O&M periods.

Of the base scenarios, over 20 years a coal-fired power plant will have the largest statewide economic impact. This is due to the assumption that 100% of the fuel consumed in such a plant will be mined in Utah. Wind farms show slightly greater overall impact than natural-gas-fired plants. Looking only at the construction period, wind farms have significantly larger impacts than the other technologies.

Figure 2: Results for Selected Scenarios *(Base case scenarios shaded)*

	Wind - 2500 MW	Coal - 1000 MW 100% in-state	Coal - 1000 MW 0% in-state	Gas - 1500 MW 100% in-state	Gas - 1500 MW 25% in-state	Gas - 1500 MW 0% in state
Cost of Fuel ($/MMBTU)		**1.3**	**N/A**	**5.2**	**5.2**	**N/A**
Totals						
Total Output (Construction + O&M)	**$ 3,282**	**$ 5,277**	**$ 2,093**	**$ 10,440**	**$ 3,439**	**$ 1,105**
Total Earnings (Construction + O&M)	**$ 1,434**	**$ 1,795**	**$ 880**	**$ 3,151**	**$ 1,137**	**$ 466**
Construction Period						
Total Jobs (job-years)	7,574	6,415	6,415	4,510	4,510	4,510
Total Earnings ($)	$ 228	$ 191	$ 191	$ 134	$ 134	$ 134
Total Output ($million)	$ 746	$ 625	$ 625	$ 439	$ 439	$ 439
Operations (Each Year)						
Total Jobs	1,363	1,872	739	3,646	1,155	324
Total Earnings ($million/year)	$ 60	$ 80	$ 34	$ 151	$ 50	$ 17
Total Output ($milion/year)	$ 127	$ 233	$ 73	$ 500	$ 150	$ 33
Total 20 Years Earnings from Operations	$ 1,206	$ 1,604	$ 689	$ 3,017	$ 1,003	$ 332
Total 20 Years Output from Operations	$ 2,536	$ 4,653	$ 1,469	$ 10,000	$ 2,999	$ 666
Breakdowns						
Construction Period						
Jobs - direct (job-years)	4,115	3,531	3,531	2,483	2,483	2,483
Jobs - construction sector only (job-years)	3,934	3,528	3,528	2,463	2,463	2,463
Jobs - indirect	1,835	1,556	1,556	1,096	1,096	1,096
Jobs - induced	1,624	1,327	1,327	932	932	932
Earnings - direct ($million)	$ 130	$ 109	$ 109	$ 76	$ 76	$ 76
Earnings - construction sector only ($million)	$ 121	$ 108	$ 108	$ 76	$ 76	$ 76
Earnings - indirect ($million)	$ 55	$ 46	$ 46	$ 33	$ 33	$ 33
Earnings - induced ($million)	$ 44	$ 36	$ 36	$ 25	$ 25	$ 25
Output - direct ($million)	$ 457	$ 385	$ 385	$ 271	$ 271	$ 271
Output - construction sector only ($million)		$ 384	$ 384	$ 268	$ 268	$ 268
Output - indirect ($million)	$ 150	$ 127	$ 127	$ 89	$ 89	$ 89
Output - induced ($million)	$ 138	$ 113	$ 113	$ 79	$ 79	$ 79
Operations (Each Year)						
Jobs - direct	648	836	361	1,534	491	143
Jobs - plant workers only	325	102	102	76	76	76
Jobs - indirect	269	526	158	1,149	341	72
Jobs - induced	445	511	219	964	323	109
Earnings - direct ($million)	$ 40	$ 49	$ 24	$ 87	$ 30	$ 11
Earnings - plant workers only ($million)	$ 30	$ 15	$ 15	$ 9	$ 9	$ 9
Earnings - indirect ($million)	$ 8	$ 17	$ 5	$ 38	$ 11	$ 2
Earnings - induced ($million)	$ 12	$ 14	$ 6	$ 26	$ 9	$ 3
Output - direct ($million)	$ 64	$ 138	$ 40	$ 304	$ 89	$ 17
Output - plant workers only ($million)		$ 15	$ 15	$ 9	$ 9	$ 9
Output - indirect ($million)	$ 25	$ 51	$ 14	$ 114	$ 33	$ 7
Output - induced ($million)	$ 38	$ 44	$ 19	$ 82	$ 28	$ 9
Land Lease ($million/year)	$ 6.7					
Property Taxes ($million/year)	$ 39.0	$ 13.9	$ 13.9	$ 9.0	$ 9.0	$ 9.0

Figure 3: Total Output for Selected Cases

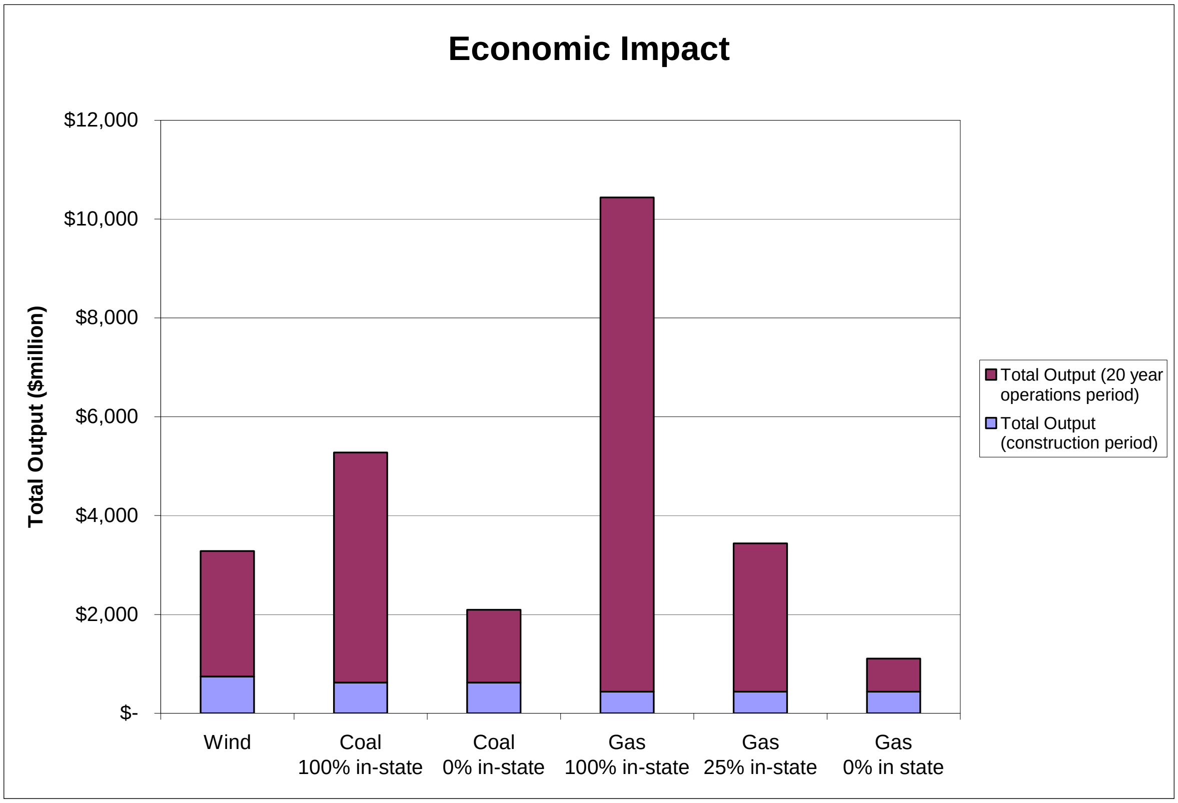


Figure 4: Total Earnings for Selected Cases

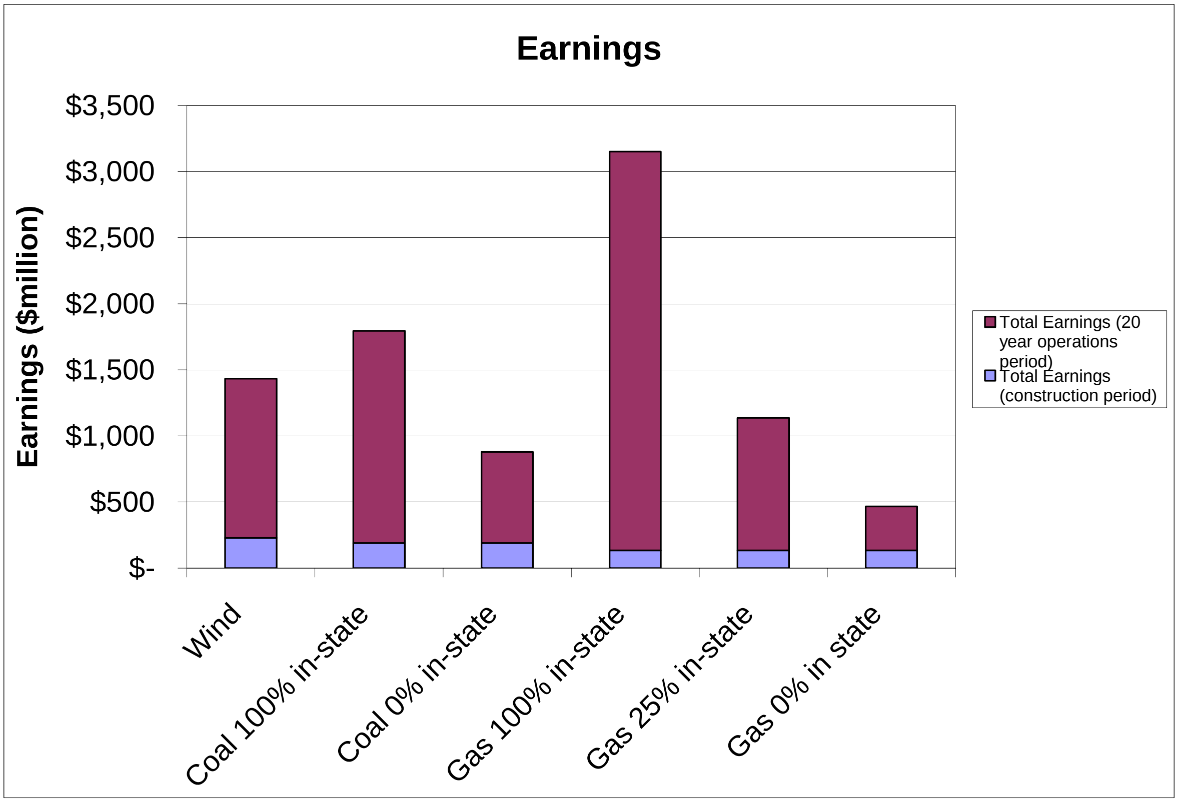
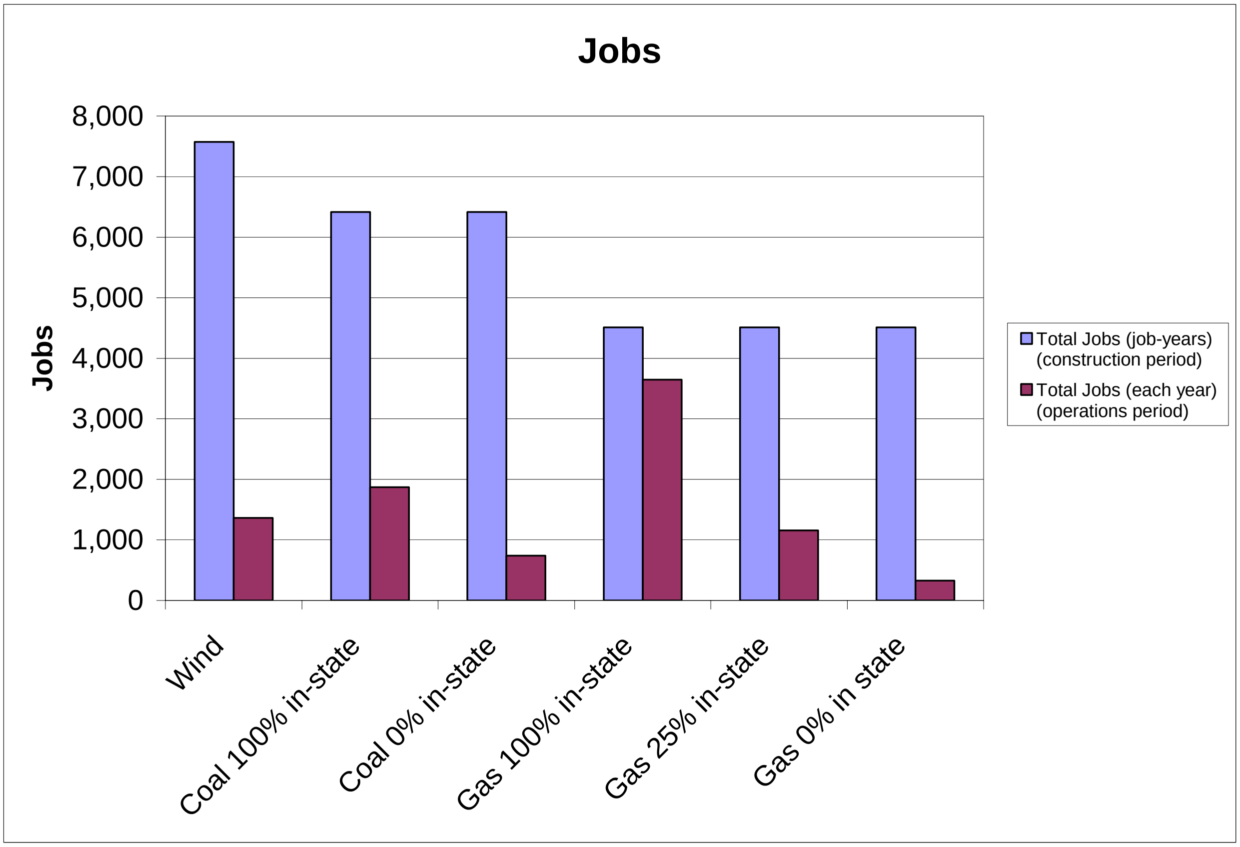


Figure 5: Total Jobs for Selected Cases



Even a casual perusal of the results immediately shows the dramatic impact of the fuel chain for fossil fuel plants. Going from 0% to 100% in-state fuel purchases multiplies the economic impact of a coal plant and a natural gas plant by a factor of 2.5 and 9, respectively. With 0% in-state fuel, the total (economic) output for a wind farm is 50% greater than a coal plant and three times greater than a natural gas plant. With 100% in-state fuel, coal plants have two-thirds more economic output than wind farms, while natural gas plants have more than three times the economic output.

Another noticeable result is that for all cases except one, the output due to the operations period is much greater than the output due to the construction period. Even though on an annual basis the operations period output is smaller, the cumulative total after 20 years is large. This is especially true in cases in which the fuel comes from within the state. Only in the case of a natural gas plant with no in-state fuel are the construction and O&M period benefits comparable.

Results – Effects of Fuel Costs

Figure 6 and Figure 7 show the effects of fuel price on economic output. According to the model, output, earnings, and number of jobs vary greatly with fuel price. Greater fuel prices lead to greater output. Part of this variation is an artifact of the model. Recall that input-output models such as JEDI correlate demand or dollars spent to jobs, earnings, and output. In the case of the fuel chain, the number of jobs created resulting from fuel purchases is directly associated with the amount spent, not necessarily the quantity of fuel purchased, although they are related. In JEDI, one could double the price of fuel and halve the percentage of fuel supplied in-state and the economic impacts (according to JEDI) would be similar. Intuitively, this doesn't seem totally right. The economic impact due to fuel purchases depends both on the amount of fuel purchased and the price paid for that fuel. To a point, increases in fuel prices will lead to more investment and jobs within that sector. However, some of the increase is negated by higher upstream costs, and some of the added profit may flow toward investors rather than add to local economies. In the view of this author, changes in fuel price do lead to changes in economic impact, but JEDI overstates these changes.

Figure 6: Effects of Fuel Cost Graph

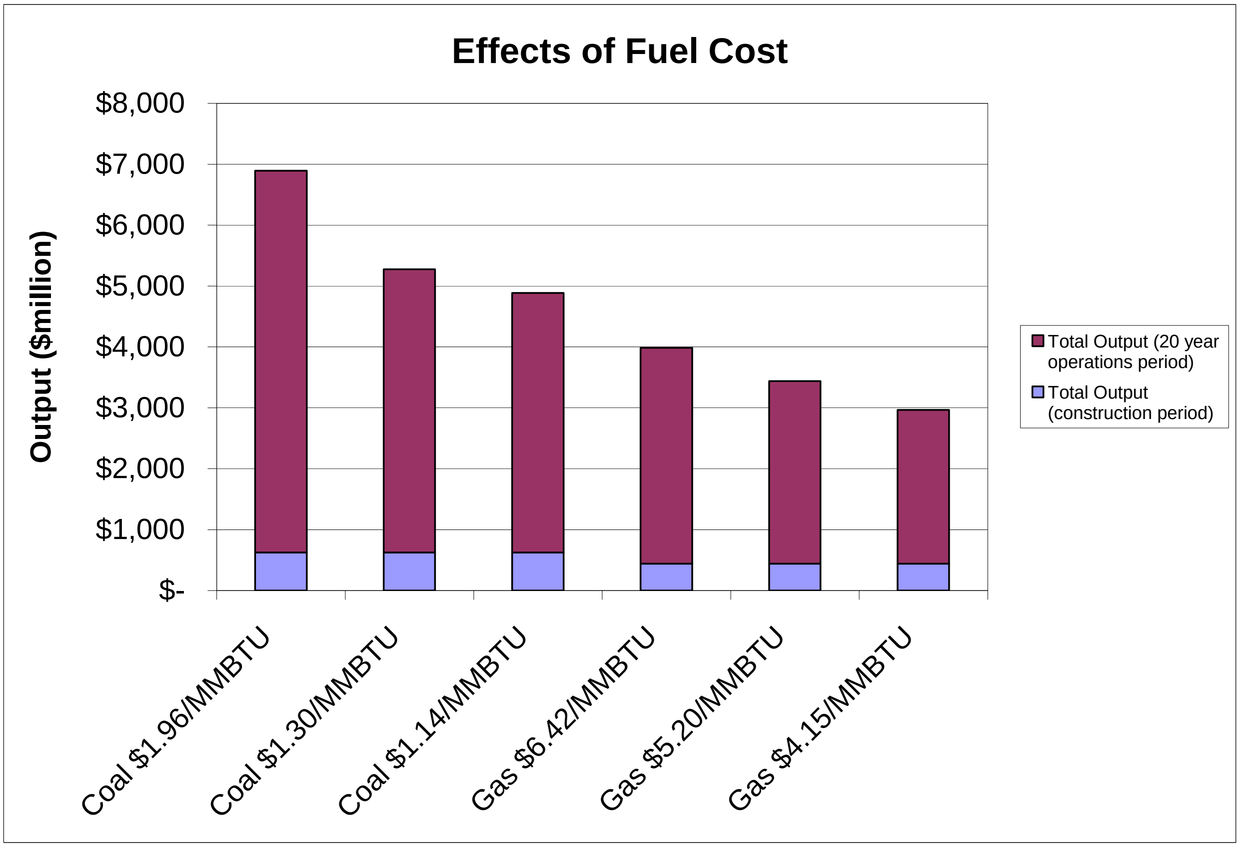


Figure 7: Effects of Fuel Cost – Table *(Base case scenarios shaded)*

	Coal $1.96/MMBTU	Coal $1.30/MMBTU	Coal $1.14/MMBTU	Gas $6.42/MMBTU	Gas $5.20/MMBTU	Gas $4.15/MMBTU
Total Output (construction period)	$ 625	$ 625	$ 625	$ 439	$ 439	$ 439
Total Output (20-year operations period)	$ 6,269	$ 4,653	$ 4,261	$ 3,547	$ 2,999	$ 2,528
Total Earnings (construction period)	$ 191	$ 191	$ 191	$ 134	$ 134	$ 134
Total Earnings (20-year operations period)	$ 2,069	$ 1,604	$ 1,492	$ 1,161	$ 1,003	$ 868
Total Jobs (job-years) (construction period)	6,415	6,415	6,415	4,510	4,510	4,510
Total Jobs (each year) (operations period)	2,447	1,872	1,733	1,350	1,155	987
Total Annual Earnings	$ 103	$ 80	$ 75	$ 58	$ 50	$ 43
Total Annual Output	$ 313	$ 233	$ 213	$ 177	$ 150	$ 126

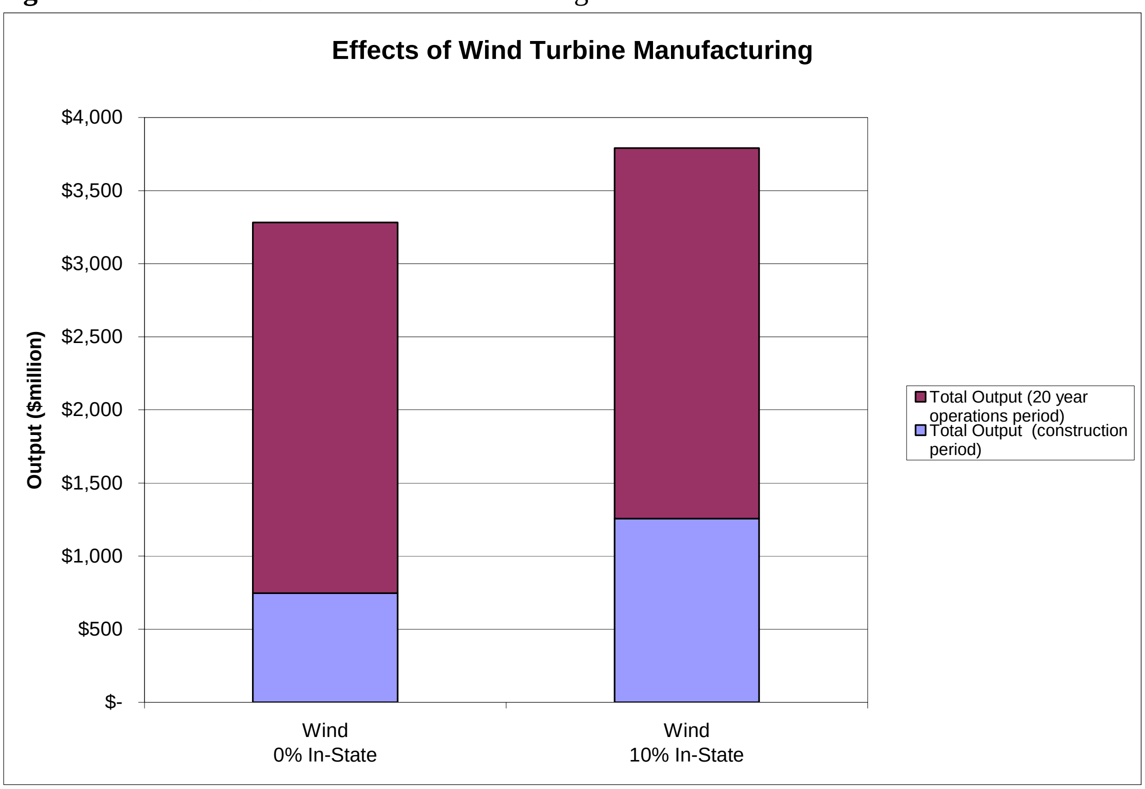
Results – Effects of In-State Wind Turbine Manufacturing

To examine the impacts of wind turbine manufacturing within Utah, a sensitivity analysis was performed assuming that 10% of the wind turbine components are purchased from in-state manufacturers. Figure 8 and Figure 9 show the results. The economic output increases by 15% ($500 million) from $3.3 billion to $3.8 billion.

Figure 8: Effects of Wind Turbine Manufacturing *(Base case scenario shaded)*

	Wind 0% In-State	Wind 10% In-State
Total Output (construction period)	$ 746	$ 1,255
Total Output (20-year operations period)	$ 2,536	$ 2,536
Total Earnings (construction period)	$ 228	$ 365
Total Earnings (20-year operations period)	$ 1,206	$ 1,206
Total Jobs (job-years) (construction period)	7,574	11,448
Total Jobs (each year) (operations period)	1,363	1,363
Total Annual Earnings	$ 60	$ 60
Total Annual Output	$ 127	$ 127

Figure 9: Effects of Wind Turbine Manufacturing



Results – Regional Effects within Utah

It should be noted that the development of wind projects in Utah holds the potential for energy and economic development in areas of the state that are not otherwise rich in energy resources. Much of the economic impact shown in the base case scenarios examined in this analysis comes from coal and natural gas extraction activities. Thus, development of new plants using these fuels can be expected to add to employment and economic development in areas that already produce these fuels. The development of wind projects can spread the economic benefits of energy production across a wider range of locales within the state. Moreover, the significantly larger property tax benefits that result from wind projects can provide local governments with a major source of new revenue that may be used for further economic development projects within individual counties.

Summary and Conclusions

- Assuming 100% in-state fuel purchases and given the assumptions and inputs described earlier, natural gas plants have the largest overall economic impact, followed by coal plants and then wind farms.
- Excluding the fuel supply chain, the relative economic impacts are reversed. Wind farms have the greatest economic impact, followed by coal plants and then natural gas plants.
- Natural gas plants with 25% in-state fuel and wind farms have a roughly similar overall economic impact.
- For fossil fuel plants, the economic impact depends heavily on the fraction of fuel coming from in-state resources. With 100% in-state fuel, the economic impact of the fuel supply chain is greater than that of the power plant.
- For all technologies, the cumulative impact from the O&M period is greater than the impact during the construction period.
- For fossil fuel plants with a significant fraction of in-state fuel, JEDI shows the overall economic impact is very sensitive to the fuel price. JEDI probably overstates the sensitivity of economic impact to fuel price.
- Capturing even a small fraction of the wind turbine manufacturing supply value chain will lead to a noticeable increase in the economic impact of wind farms. It is reasonable to assume that a significant level of wind farm installations within Utah will lead to wind component manufacturers establishing operations in Utah. This is not the case for coal or natural gas manufacturers.

Discussion and Caveats

JEDI ignores externalities such as the effect of cost of energy on utility rates, pollution, water use, potential carbon taxes, etc. Of these items, the most important for the purpose of this analysis is the cost of energy. JEDI results implicitly assume that the resulting costs of energy from the respective technologies have no effect on economic activity. This is untrue. Higher costs of energy typically lead to higher electricity rates, which leave ratepayers with less money to spend on other goods and services. Lower rates have the opposite effect. Thus when the effect of rates is considered, the net economic impact of technologies with a higher cost of energy will be reduced. Similarly, technologies with a lower cost of energy will have added economic impact. At the time of this writing, when comparing new power plants, coal and wind have about the same cost of energy, while natural gas is more expensive.

From an input-output modeling perspective, high fuel prices may seem desirable because they lead to greater economic output. (As has been previous discussed, JEDI may exaggerate this impact.) However, the greater output resulting from higher fuel prices may be offset by reduced ratepayer spending on other items (due to higher electricity bills) that are not modeled in this analysis. Conversely, the reduced economic impact of lower fuel prices is offset by increased ratepayer spending in other economic sectors.

Exactly how this plays out is beyond the scope of this analysis. In the end, changes in economic impact due to changes in in-state fuel prices may be quite modest.

One final consideration is the opportunity cost of using coal and natural gas in-state versus exporting them. Utah is blessed to have its own coal and natural gas resources. The majority of the economic impact of natural gas and coal plants comes from the fuel supply chain. However, Utah can, and presumably does, reap the same economic benefits of its natural gas and coal production by exporting these resources instead of consuming them in local power plants. Indeed, Utah will only experience the economic impact of coal and natural gas supply chains associated with coal and natural gas plants to the extent that these chains can expand to meet the increased in-state demand. To the extent that increased in-state fuel demand is met by decreasing fuel exports, Utah will only see the economic impact associated with the power plant, not the associated fuel chain. If production is not constrained, then from a purely economic perspective, developing coal and natural gas plants may be the preferred alternative. However, if production is constrained, there is significant out-of-state demand, or environmental factors are considered, Utah has an opportunity to expand economic development in the state by building wind farms. At the same time, this strategy could help create a new Utah wind manufacturing and service related industry and free up coal and natural gas resources for export.

Appendix A1 – Coal Plant Assumptions

Project Cost Data - Default Values				
Construction Costs	**Cost**	**Cost Per KW**	**Percent of Total Cost**	**Local Share**
Facility and Equipment				
Power Generation	$228,229,052	$228	14.8%	0%
General facilities	$174,403,439	$174	11.3%	75%
Plant Equipment	$489,110,550	$489	31.8%	0%
Facility and Equipment Subtotal	$891,743,041	$892	57.9%	
Labor				
Construction Labor	$496,847,709	$497	32.3%	50%
Project management	$26,752,291	$27	1.7%	0%
Labor Subtotal	$523,600,000	$524	34.0%	
Construction Subtotal	$1,415,343,041	$1,415	91.9%	
Other Costs				
Engineering	$97,793,719	$98	6.4%	0%
Construction insurance	$15,045,188	$15	1.0%	0%
Land	$204,818	$0	0.0%	100%
Catalysts & chemicals	$1,680,754	$2	0.1%	10%
Grid intertie	$5,045,857	$5	0.3%	100%
Spare Parts	$4,886,623	$5	0.3%	2%
Other Subtotal	$124,656,959	$125	8.1%	
Total	$1,540,000,000	$1,540	100.0%	

Annual Operating and Maintenance Costs				
	Cost	**Cost**	**Percent of**	**Local Share**
Fixed Costs		**Per KW**	**Total Cost**	
Labor	$16,238,898	$16	10.7%	100%
Materials	$14,034,838	$14	9.3%	25%
Services	$9,726,264	$10	6.4%	85%
Fixed Subtotal	$40,000,000	$40	26.4%	
		Cost		
Variable Costs		**Per MWh**		
Ash/sludge disposal	$7,117,998	$0.90	4.7%	100%
Water	$804,121	$0.10	0.5%	100%
Catalysts & chemicals	$5,874,881	$0.75	3.9%	10%
Variable Subtotal	$13,797,000	$1.75	9.1%	
Fuel Cost	$97,879,860	$12.42	64.5%	100%
Total	$151,676,860		100.0%	

Other Parameters		
Financial Parameters		**Local Share**
Debt Financing		
Percentage financed	80%	0%
Years financed (term)	20	
Interest rate	10%	
Equity Financing/Repayment		
Percentage equity	20%	
Individual Investors (percent of equity)	0%	100%
Corporate Investors (percent of equity)	100%	0%
Return on equity	16%	
Repayment term (years)	10	
Tax Parameters		
Local Property/Other Tax Rate (percent of taxable value)	1.2%	
Assessed Value (percent of construction cost)	100%	
Taxable Value (percent of assessed value)	75%	
Taxable Value	$1,155,000,000	
Local Taxes	$13,860,000	100%
Land Lease Parameters		
Land Lease (total cost)	$0	
Lease Payment Recipient (F = farmer/household, O = Other)	O	100%

Appendix A2 - Natural Gas Plant Assumptions

Project Cost Data - Default Values				
Construction Costs	**Cost**	**Cost Per KW**	**Percent of Total Cost**	**Local Share**
Facility and Equipment				
Power Generation	$488,023,038	$325	48.8%	0%
General facilities	$276,607,954	$184	27.6%	75%
Plant Equipment	$30,383,433	$20	3.0%	0%
Facility and Equipment Subtotal	$795,014,425	$530	79.5%	
Labor				
Construction Labor	$86,191,222	$57	8.6%	50%
Project management	$26,351,918	$18	2.6%	0%
Labor Subtotal	$112,543,139	$75	11.2%	
Construction Subtotal	$907,557,564	$605	90.7%	
Other Costs				
Engineering	$56,865,638	$38	5.7%	0%
Construction insurance	$10,188,221	$7	1.0%	0%
Land	$2,310,826	$2	0.2%	100%
Catalysts & chemicals	$324,846	$0	0.0%	10%
Grid intertie	$17,722,004	$12	1.8%	100%
Spare Parts	$5,530,900	$4	0.6%	2%
Other Subtotal	$92,942,436	$62	9.3%	
Total	$1,000,500,000	$667	100.0%	

Annual Operating and Maintenance Costs				
Fixed Costs	**Cost**	**Cost Per KW**	**Percent of Total Cost**	**Local Share**
Labor	$9,614,250	$6	3.0%	100%
Materials	$1,959,756	$1	0.6%	25%
Services	$3,425,994	$2	1.1%	85%
Fixed Subtotal	$15,000,000	$10	4.7%	
Variable Costs		**Cost Per MWh**		
Water	$223,867	$0.03	0.1%	100%
Catalysts & chemicals	$17,909,333	$2.27	5.6%	10%
Variable Subtotal	$18,133,200	$2.30	5.7%	
Fuel Cost	$286,977,600	$36.40	89.6%	25%
Total	$320,110,800		100.0%	

Other Parameters		
Financial Parameters		**Local Share**
Debt Financing		
Percentage financed	80%	0%
Years financed (term)	20	
Interest rate	10%	
Equity Financing/Repayment		
Percentage equity	20%	
Individual Investors (percent of equity)	0%	100%
Corporate Investors (percent of equity)	100%	0%
Return on equity	16%	
Repayment term (years)	10	
Tax Parameters		
Local Property/Other Tax Rate (percent of taxable value)	1.2%	
Assessed Value (percent of construction cost)	100%	
Taxable Value (percent of assessed value)	75%	
Taxable Value	$750,375,000	
Local Taxes	$9,004,500	100%
Land Lease Parameters		
Land Lease (total cost)	$0	
Lease Payment Recipient (F = farmer/household, O = Other)	O	100%

Appendix A3 – Wind Farm Assumptions

Project Cost Data - Default Values				
Construction Costs	**Cost**	**Cost**	**Percent of**	
Materials		**Per KW**	**Total Cost**	**Local Share**
Construction (concrete, rebar, equip, roads and site pre	$210,145,688	$84	5.3%	90%
Transformer	$53,085,583	$21	1.3%	0%
Electrical (drop cable, wire,)	$24,895,308	$10	0.6%	100%
HV line extension	$45,763,434	$18	1.1%	100%
Materials Subtotal	$333,890,013	$134	8.3%	
Labor				
Foundation	$18,305,374	$7	0.5%	100%
Erection	$18,305,374	$7	0.5%	75%
Electrical	$20,135,911	$8	0.5%	75%
Management/supervision	$10,983,224	$4	0.3%	0%
Labor Subtotal	$67,729,882	$27	1.7%	
Construction Subtotal	$401,619,895	$161	10.0%	
Equipment Costs				
Turbines (excluding blades and towers)	$2,197,200,000	$879	54.9%	0%
Blades	$732,400,000	$293	18.3%	0%
Towers	$460,000,000	$184	11.5%	0%
Equipment Subtotal	$3,389,600,000	$1,356	84.7%	
Other Costs				
HV Sub/Interconnection	$146,442,988	$59	3.7%	100%
Engineering	$48,000,000	$19	1.2%	0%
Legal Services	$3,720,000	$1	0.1%	100%
Land Easements	$0	na	0.0%	100%
Site Certificate/Permitting	$10,617,117	$4	0.3%	100%
Other Subtotal	$208,780,105	$84	5.2%	
Total	$4,000,000,000	$1,600	100.0%	

Wind Plant Annual Operating and Maintenance Costs				
	Cost	**Cost**	**Percent of**	**Local Share**
Personnel		**Per KW**	**Total Cost**	
Field Salaries	$22,117,786	$8.85	35.4%	100%
Adminstrative	$2,645,581	$1.06	4.2%	100%
Manangement	$7,938,117	$3.18	12.7%	100%
Personnel Subtotal	$32,701,484	$13.08	52.3%	
Materials and Services				
Vehicles	$2,085,896	$0.83	3.3%	100%
Misc. Services	$5,959,703	$2.38	9.5%	80%
Fees, Permits, Licenses	$2,085,896	$0.83	3.3%	100%
Utilities	$5,959,703	$2.38	9.5%	100%
Insurance	$8,939,555	$3.58	14.3%	0%
Fuel (motor vehicle gasoline)	$1,489,926	$0.60	2.4%	100%
Tools and Misc. Supplies	$2,383,881	$0.95	3.8%	100%
Spare Parts Inventory	$893,955	$0.36	1.4%	2%
Materials and Services Subtotal	$29,798,516	$11.92	47.7%	
Total	$62,500,000	$25.00	100.0%	

Other Parameters		
Financial Parameters		**Local Share**
Debt Financing		
Percentage financed	80%	0%
Years financed (term)	10	
Interest rate	10%	
Equity Financing/Repayment		
Percentage equity	20%	
Individual Investors (percent of total equity)	0%	100%
Corporate Investors (percent of total equity)	100%	0%
Return on equity (annual interest rate)	16%	
Repayment term (years)	10	
Tax Parameters		
Local Property/Other Tax Rate (percent of taxable value)	1.3%	
Assessed value (percent of construction cost)	100%	
Taxable Value (percent of assessed value)	75%	
Taxable Value	$3,000,000,000	
Local Taxes	$39,000,000	100%
Land Lease Parameters		
Land Lease Cost (per tubine)	$4,000	
Number of Turbines	1,667	
Land Lease (total cost)	$6,668,000	
Lease Payment recipient (F = farmer/household, O = Other)	F	100%

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Acknowledgements

I wish to thank Philip Powlick and the staff at the Utah State Energy Program for gathering needed data for the analysis, valuable discussions, and detailed review of draft reports. His efforts resulted in a fruitful collaboration.

I wish to thank Marshall Goldberg of MRG & Associates and my colleagues at NREL, Michael Milligan and Marguerite Kelly, for sharing ideas and providing assistance for this analysis and report.

This work was supported by a U.S. Department of Energy Technical Assistance Program (TAP) grant.